Issued April 8, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 320.

Experiment Station Work,

XLVI.

Compiled from the Publications of the Agricultural Experiment Stations.

MARCH, 1908.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

THE AGRICULTURAL EXPERIMENT STATIONS.

ALABAMA—
College Station: *Auburn;* J. F. Duggar.[a]
Canebrake Station: *Uniontown;* F. D. Stevens.[a]
Tuskegee Station: *Tuskegee Institute;* G. W. Carver.[a]

ALASKA—*Sitka:* C. C. Georgeson.[b]

ARIZONA—*Tucson:* R. H. Forbes.[a]

ARKANSAS—*Fayetteville:* W. G. Vineenheller.[a]

CALIFORNIA—*Berkeley:* E. J. Wickson.[a]

COLORADO—*Fort Collins:* L. G. Carpenter.[a]

CONNECTICUT—
State Station: *New Haven;* E. H. Jenkins.[a]
Storrs Station: *Storrs;* L. A. Clinton.[a]

DELAWARE—*Newark:* Harry Hayward.[a]

FLORIDA—*Gainesville:* P. H. Rolfs.[a]

GEORGIA—*Experiment:* Martin V. Calvin.[a]

HAWAII—
Federal Station: *Honolulu;* J. G. Smith.[b]
Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]

IDAHO—*Moscow:* H. T. French.[a]

ILLINOIS—*Urbana:* E. Davenport.[a]

INDIANA—*Lafayette:* A. Goss.[a]

IOWA—*Ames:* C. F. Curtiss.[a]

KANSAS—*Manhattan:* C. W. Burkett.[a]

KENTUCKY—*Lexington:* M. A. Scovell.[a]

LOUISIANA—
State Station: *Baton Rouge.*
Sugar Station: *Audubon Park, New Orleans.*
North Louisiana Station: *Calhoun;* W. R. Dodson (*Baton Rouge*).[a]

MAINE—*Orono:* C. D. Woods.[a]

MARYLAND—*College Park:* H. J. Patterson.[a]

MASSACHUSETTS—*Amherst:* W. P. Brooks.[a]

MICHIGAN—*East Lansing:* C. D. Smith.[a]

MINNESOTA—*St. Anthony Park, St. Paul:* E. W. Randall.[a]

MISSISSIPPI—*Agricultural College:* W. L. Hutchinson.[a]

MISSOURI—
College Station: *Columbia;* H. J. Waters.[a]

MISSOURI—Continued.
Fruit Station: *Mountain Grove;* P. Evans.[a]

MONTANA—*Bozeman:* F. B. Linfield.[a]

NEBRASKA—*Lincoln:* E. A. Burnett.[a]

NEVADA—*Reno:* J. E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* E. D. Sanderson.[a]

NEW JERSEY—*New Brunswick:* E. B. Voorhees.[a]

NEW MEXICO—*Agricultural College:* L. Foster.[a]

NEW YORK—
State Station: *Geneva;* W. H. Jordan.[a]
Cornell Station: *Ithaca;* L. H. Bailey.[a]

NORTH CAROLINA—
College Station: *West Raleigh;* C. B. Williams.[a]
State Station: *Raleigh;* B. W. Kilgore.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Wooster:* C. E. Thorne.[a]

OKLAHOMA—*Stillwater:* W. L. English.[a]

OREGON—*Corvallis:* J. Withycombe.[a]

PENNSYLVANIA—
State College: T. F. Hunt.[a]
State College: Institute of Animal Nutrition, H. P. Armsby.[a]

PORTO RICO—*Mayaguez:* D. W. May.[b]

RHODE ISLAND—*Kingston:* H. J. Wheeler.[a]

SOUTH CAROLINA—*Clemson College:* J. N. Harper.[a]

SOUTH DAKOTA—*Brookings:* J. W. Wilson.[a]

TENNESSEE—*Knoxville:* H. A. Morgan.[a]

TEXAS—*College Station:* H. H. Harrington.[a]

UTAH—*Logan:* E. D. Ball.[a]

VERMONT—*Burlington:* J. L. Hills.[a]

VIRGINIA—*Blacksburg:* S. W. Fletcher.[a]

WASHINGTON—*Pullman:* R. W. Thatcher.[a]

WEST VIRGINIA—*Morgantown:* J. H. Stewart.[a]

WISCONSIN—*Madison:* H. L. Russell.[a]

WYOMING—*Laramie:* J. D. Towar.[a]

[a] Director.

[b] Special agent in charge.

EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

CONTENTS OF NO. XLVI.

EXPERIMENT STATION WORK.[a]

FISH FERTILIZER.[b]

Dried and ground fish or fish guano is a valuable fertilizer furnishing nitrogen and phosphoric acid, which finds quite extensive use in this and other countries where the material is available. The use of fish as a fertilizer in this country dates from the time of the earliest settlement at Plymouth, for it is reported that Squanto, an Indian, taught the Plymouth colonists to put a menhaden under each hill of corn at the time of planting to increase the yield. Untreated fish and fish waste have been used to a considerable extent as a fertilizer either directly or in composts with other materials ever since that time in regions where such materials are abundant and easily obtained.

The fish fertilizer or fish guano now commonly in use, however, is a manufactured product derived from two main sources—(1) the refuse from fish packing and canning establishments, and (2) the pomace from the extraction of oil from inedible fish. By far the larger proportion of the fish fertilizer produced in the United States is prepared from the menhaden, which is taken in immense numbers, especially along the Atlantic coast. According to a report of the U. S. Bureau of Fisheries, over 85,000 tons of fish fertilizer, valued at more than $1,500,000, was made from menhaden in the United States in 1903, and about 20,000 tons, valued at $200,000, from miscellaneous fish products. Catches of from 800,000,000 to 1,000,000,000 menhaden, weighing in the aggregate from 250,000 to 400,000 tons, during a single season on the North Atlantic coast, have been reported.

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Connecticut State Sta. Rpts. 1897, p. 257; 1900, p. 95; 1907–8, pt. 1, p. 44; Maine Sta. Bul. 88; New Jersey Stas. Rpt. 1901, p. 137; North Carolina Sta. Bul. 190; Washington Sta. Bul. 44; U. S. Fish Com. Rpt. 1902, p. 253; Report of the Commissioners on Fisheries and Game upon the Damage Caused to the Fisheries of Massachusetts by Dogfish during the Year 1905 (Boston, 1906, p. 61); Canada Expt. Farms Rpts. 1906, p. 158; Amer. Fert., 19 (1903), No. 6, p. 7; Ann. Sci. Agron., 3. ser., 1 (1906), I, No. 2, p. 166.

The product prepared from the menhaden is especially rich in fertilizing constituents, containing from 7 to 8 per cent of nitrogen and 6 to 8 per cent of phosphoric acid. The oil is removed from the menhaden and the material is prepared for use as a fertilizer by cooking in water in tanks heated with steam coils. This is the so-called process of tanking and is employed to remove the oil, which is a valuable commercial product, but interferes materially with the availability of the fertilizing constituents of the fish if not removed. The steaming also has a direct effect in increasing the availability of the phosphoric acid as well as the nitrogen of the fish. The boiling is continued until the oil rises to the surface and can be drawn off with the water, from which it is afterwards separated. The residue in the tanks is pressed in hydraulic presses, dried, and ground. In some cases the material is subjected after the first pressing to steam under pressure and to treatment with 5 per cent sulphuric acid to render the fertilizing constituents, particularly the phosphoric acid, more available.

The dry ground fish, or fish guano, obtained by this process is used to some extent directly as a fertilizer, but is usually mixed with other fertilizing materials (potash and phosphates) to make a better balanced complete fertilizer. The availability of the nitrogen in fish fertilizer prepared in this way is nearly as great as that of dried blood and tankage, which are considered among the best of the organic sources of nitrogen in fertilizers.[a] The phosphoric acid is also frequently more available than that in other organic matter.

Fertilizer prepared from fish waste from packing and canning establishments is more variable in its nitrogen content than that prepared from menhaden, owing to varying water content and proportion of bone, skin, and flesh in such waste. It is likely to be poorer in nitrogen and relatively richer in phosphoric acid than the menhaden product. According to Voorhees, the nitrogen in untreated fish scrap varies from 2.5 to 8 per cent and the phosphoric acid from 2 to 6 per cent, and these fertilizing constituents are much less available than in the tanked, dried, and finely ground material.

A large part of the fish offal accumulating at canneries and fish-packing establishments, particularly in the Columbia River region and in Alaska, which might be profitably used, is now wasted, but steps are being taken to establish fertilizer factories for the utilization of this material in these regions. In regions where it can be readily obtained from fishermen, fish scrap and waste are frequently used without preparation of any kind. Various methods of composting and other simple processes of treating fish for use as a fertilizer have been used with more or less success on a small scale.

[a] U. S. Dept. Agr., Farmers' Bul. 73, p. 7.

A report of the U. S. Bureau of Fisheries describes a method of composting as follows:

> A convenient process of converting a small quantity of refuse from dressing fish into fertilizer is to store it in a receptacle made in the ground. This should be about 5 or 6 feet deep, with the area depending on the amount of refuse, but usually about 6 feet square. It should be dry, and if the soil is sandy some clay should be spread at the bottom. First is placed a layer of wood ashes a few inches deep and then an equal layer of fish refuse covered by a sprinkling of lime. Then follow another layer of ashes, one of fish refuse sprinkled with lime, and so on until the hole is full. It should be covered with earth or sod and these covered with weighted boards and permitted to so remain for several months. The fish refuse quickly disintegrates and becomes mixed with the ashes, forming an excellent fertilizer.

It should be borne in mind in preparing such composts as this that the use of caustic alkaline substance such as wood ashes and lime in connection with easily decomposable organic matter, while admirably suited to the quick reduction of the material to a fine mechanical condition, is likely to result in the loss of a considerable amount of the nitrogen, which is the most valuable fertilizing constituent of the fish.

In the purchase of untreated fish and fish offal for direct use as a fertilizer farmers should be guided by the amount of water which it contains. Fresh fish and wet fish offal are very variable in water content, but probably contain on the average 50 to 60 per cent of water, with correspondingly lower percentages of nitrogen and phosphoric acid than the comparatively dry residue from oil extraction. It would hardly be profitable to transport such watery materials any considerable distance unless they could be obtained at a very low price. Voorhees states that if material of this kind containing 2.5 per cent of nitrogen can be obtained at $5 per ton it can be profitably used by farmers.

Fish and fish scrap have been successfully converted into fertilizer by simply drying and grinding. In this case it has been recommended to add a small amount of sulphuric acid (5 per cent) or muriate of potash to check offensive fermentation and to increase the fertilizing value of the resulting product. In Norway, which is one of the largest producers of fish fertilizer in the world, a common method is to spread the fish scrap on the rocks to dry, afterwards grinding it to the condition of a coarse meal. The Norwegian product is generally distinguished from the American fish fertilizer by its higher percentage of phosphoric acid and lower percentage of nitrogen.

Recently the possibility of utilizing the dogfish, which is proving so injurious to the fishery interests of the North Atlantic coast, for the manufacture of fertilizers, has been receiving considerable atten-

tion, especially by the Commissioners of Fisheries and Game of Massachusetts and the Department of Marine and Fisheries of Canada, and factories, notably one in Nova Scotia and two others in New Brunswick, have been established for this purpose under the auspices of the latter department. Analyses by F. T. Shutt, of the Canada Experimental Farms, of the products of these factories show a nitrogen content varying from 7.59 to 9.41 per cent and phosphoric acid from 2.94 to 6.49 per cent. The product is therefore of high value as regards nitrogen and phosphoric-acid contents. The samples examined, however, contained a very high percentage of oil (22.81 to 32.75 per cent), which seriously detracts from the fertilizing value of the product. There seems to be no insurmountable difficulty in the way of converting the dogfish into a high-grade fertilizer comparing favorably with the best forms of fish fertilizer, provided the dogfish can be supplied in sufficient amount to keep the factories running on an economical basis.

The foregoing statements, based upon a large amount of work by various experiment stations, make it plain that there is obtained from fish and fish waste a very valuable fertilizer, furnishing considerable percentages of both nitrogen and phosphoric acid, the former in readily available form. Fish fertilizer is especially valuable as a carrier of nitrogen either for direct use or in the preparation of mixed fertilizers. It should always be borne in mind that fish is deficient in potash and that in order to make a complete, well-balanced fertilizer it must be mixed with or used in combination with potash salts, and it is also improved by being reinforced with more soluble forms of phosphoric acid.

The following formulas are given by F. T. Shutt, of the Canada Experimental Farms, for combining fish with other fertilizing materials to make complete fertilizers for general use:

	Pounds.
For cereals and grass:	
Dry ground fish	300
Nitrate of soda	100
Superphosphate	300
Muriate of potash	50
Application—300 to 800 pounds per acre.	
For potatoes, roots generally, and clover:	
Dry ground fish	300
Nitrate of soda	50
Superphosphate	400
Muriate of potash	150
Application—300 to 800 pounds per acre.	

Dry sand or fine loam may be added to the mixed fertilizer to facilitate distribution. Probably the best plan of application is to broadcast the fertilizer on the thoroughly prepared land in the spring, previous to seeding, incorporating with

the soil by one or more harrowings. It has been found that fish refuse gives the best returns on moderately light, warm, moist soils.

Like other organic manures, fish fertilizer is better suited to long-season crops than to short-season, early-maturing crops. Favorable conditions for nitrification, which renders the nitrogen available to crops, are necessary to the greatest efficiency of the fish fertilizers, as of other organic nitrogenous fertilizers.

In experiments at the North Carolina Experiment Station, W. A. Withers found that while the rate of nitrification varied widely with the character of the soil, fish fertilizer in certain cases nitrified more rapidly than sulphate of ammonia, dried blood, cotton-seed meal, and bone. A warm, porous soil well supplied with lime is especially suited to the rapid nitrification of such manures as fish.

RECLAMATION OF SALT MARSHES.[a]

The New Jersey legislature in 1902 passed a bill providing, in a comprehensive way, for the locating and abolishing of mosquito-breeding salt-marsh areas, placing the management of the work in the hands of the entomologist of the New Jersey experiment stations. It was urged in favor of this bill "that in addition to the direct advantage to the State of the eradication of the mosquitoes, the indirect returns that would be derived from the drainage necessary in abolishing the mosquito-breeding areas would in a few years exceed the total appropriations asked for. This argument was based on the assumption that the water-logged marsh areas, now largely waste lands, would then grow instead grasses of commercial value. No definite statement could be made as to the area likely to be improved, nor its possible increase in value."

In order to obtain more definite information as to the benefits resulting from the drainage incidental to the mosquito extermination, as well as the possible benefits which might be derived from more thorough drainage, the executive officer in charge of the mosquito work was authorized to make such observations and investigations on the areas already drained as would serve as a basis for estimating the possible value to the State of such drainage work. In a recent report Prof. John B. Smith, the officer in charge of the mosquito work, summarizes his observations on this subject.

Three types of marsh lands were taken account of in his estimates of the possible increase of land values as a result of partial or complete drainage.

[a] Compiled from New Jersey Stas. Bul. 207; U. S. Dept. Agr., Office of Expt. Stas. Rpt. 1906, p. 373; Circ. 76.

The first and smallest in area is that which is covered at every mean high tide and which may or may not be covered with sedge or joint grass. It is an area that has never been made useful for any purpose, is not dangerous as a mosquito-breeding territory, gradually rising or making up. It merges gradually into the second type.

The second type is in area rarely covered at ordinary tides, but so little above mean high water that even the slightest rise, due to wind, storm, or moon changes, results in a watery covering. Such areas may be covered by sedge, but more usually have a scanty growth of the joint grass and are inhabited by fiddler crabs. This area is also without present value and is not dangerous as a mosquito breeder, for the burrows of the "fiddlers" provide effective drainage. Such marsh is usually very flat and level, and if holes occur they are of considerable size and naturally and continually stocked with fish and other marine organisms. This type of marsh is also gradually rising. The surface is quite generally a slippy mud, and there is not even shelter to tempt adult mosquitoes to rest on it.

The third type of marsh is all that area above mean high tide and more or less completely covered with vegetation.

These marsh lands have very little present value, although "all salt marsh of the third type may be made to produce an income of from $10 to $40 per acre annually, and all salt marsh of that type can be made of actual value. As a matter of fact, there are many hundred acres that do produce such incomes as against many times more that produce nothing—but can be made to do as well." Some of the higher lands produce a coarse hay which has some value for feed, bedding, packing, etc. Even the partial drainage carried out in the course of mosquito extermination has, in many cases, greatly increased the yield and improved the quality of the natural growth of hay.

Diking and drainage are the two recognized methods of reclaiming such marshes.

As to the relative cost of draining and diking and the cost of maintenance, that is all in favor of the drainage. An average salt marsh can be drained for about $12 an acre, and on a large marsh area the average cost per acre of mosquito drainage is much less. The cost of maintaining the ditches need not exceed $1 per annum per acre and would probably be less. No effective diking could be done at any such rate, especially as, in any case, ditching would have to supplement it to get rid of the surface water. An area once diked and placed under cultivation can not be restored as a salt marsh for many years, if ever. A well-drained salt marsh may at its highest points be cultivated and used to produce such truck crops as will grow in salt land, and is not in any way unfitted for later reclamation by diking.

A salt marsh properly drained for the production of maximum grass crop will not breed mosquitoes, because there will be no stagnant water on it anywhere. On the other hand, a mosquito-drained marsh may not be sufficiently drained for the production of maximum crops. In the mosquito work we are looking only to removing the excess of water and not to supplying water where there is none. A perfectly dry, high marsh area is untouched in the mosquito work, though it may be altogether too dry to produce the best grass crop.

Therefore, while the effect of the work now in progress will be the material improvement of all the salt-marsh area treated, it will not result in the greatest possible improvement of all the marsh.

It seems evident from what has already been accomplished that a comprehensive plan of thorough drainage is not only feasible, but is economically advisable for a large proportion of these marsh lands which cover an area of over 296,000 acres in New Jersey. It is certain "that in the State of New Jersey there are at the present time thousands of acres of land capable of being put into shape to produce good, paying crops at a comparatively small outlay of money. The methods of doing this work are well known, have been sufficiently tried out, and are effective. The adoption of some scheme to secure this improvement will add at least $2,000,000 to taxable values within the State and should add at least $250,000 to the annual income of the owners of the lands."

In a publication of this Department[a] dealing with practical methods of reclaiming tide lands, Mr. J. O. Wright says of the importance and results of draining these lands:

These waste places, rich in fertility and having an ample supply of moisture for plant growth, only need draining to enable heat and air to penetrate the ground to make them ideal locations for truck gardening on a large scale. Many of these are so situated as to offer economy in transportation which furnishes another important reason for their early reclamation. Either by rail or boat products can be landed cheaply and quickly in the market places of large cities or thriving towns at very little cost. This adds greatly to the commercial value of the land and allows for a much more liberal expenditure for its reclamation than could be borne if there had to be added to the cost of production the cost of a long-distance haul to market.

About the only agricultural product grown on these lands in their native condition is marsh hay. This hay sells at present in the vicinity of Boston at $8 a ton. On areas which have been drained the hay sells for $25 a ton, and the yield per acre is larger than on the undrained tracts. The simplest form of improvement possible, therefore, increases the productive value of these lands threefold, but the greater part of the lands which have been reclaimed are too valuable for the growing of hay, and have been brought immediately into intensive cultivation. Cranberries are probably the most important crop at present grown on tide marshes. The area of cranberry bogs is being constantly extended and the trade in this fruit has assumed large proportions. Cranberry growing during the past two or three years has been quite profitable, and this has resulted in a marked activity in the extension of the area devoted to the crop and to the value of the lands reclaimed. Good bogs along the North Atlantic coast now sell for $1,000 an acre and pay a large return on this investment. The need of these marshes for truck farming is more apparent now than formerly because of the great increase in the number and population of some seaside resorts. Along Cape Cod and much of the Massachusetts coast the uplands have not the fertility needed for successful gardening. Much better results can be had from these marshes when drained than from the higher lands. In many places the

[a] U. S. Dept. Agr., Office of Expt. Stas. Rpt. 1906, pp. 373–379.

growing of fresh vegetables in the immediate vicinity of town, requires the reclamation of marshes, and they are proving well adapted to this use. Asparagus grows with unusual vigor in such soil, and in places near Boston excellent crops are being produced where the marshes are occasionally flooded with sea water. Celery does excellently in some localities, but has failed, for reasons not well understood, in others. Cauliflower, cabbage, onions, muskmelons and watermelons, cucumbers, lettuce, sweet corn, field corn, potatoes, oats, redtop, timothy, and alsike clover are all crops being successfully grown on reclaimed marsh lands along the North Atlantic coast: onions, celery, asparagus, cucumbers, and melons being the most profitable crops.

For many years the tide marshes of the South Atlantic coast were largely devoted to rice growing, and this is still the most important use of these areas, but changes in the flow of the rivers, which have taken place as the result of the removal of the forests and from other causes not so well understood, are bringing about a change in these lands, under which they are being more and more converted into truck farms. Asparagus, peas, potatoes, lettuce, beans, and cabbage are being raised in large quantities and shipped to the northern markets for sale early in the season. The products are of good quality, the business is proving profitable, and the area is being continually extended.

The drainage of swamp and marsh lands is a leading feature of the work of the drainage investigations of the Office of Experiment Stations of this Department, and the data already obtained in these investigations throw considerable light upon the cost of reclamation by drainage under various conditions, the causes of failures, and the best methods of procedure, and they have also attracted attention to the feasibility and advantages of such reclamation.

BERMUDA HAY.[a]

Some of the first experimental work begun by the Oklahoma Station was a series of grass-culture tests, which was subsequently extended into cooperative experiments with farmers throughout the State. The earlier results of this work[b] have shown that of the different grasses grown Bermuda grass alone possessed the requirements of a pasture grass for Oklahoma conditions, and more recent experience with this species also indicates its superior value for hay as compared with the wild grasses. The following brief report on the yield of Bermuda hay obtained at the station is of interest in this connection:

The 2½ acres of upland soil that was planted to hardy Bermuda grass on June 29 and 30, 1905, has been cut for the third time this season. The first cutting in the season of 1906 was made June 12. The total yield of cured hay from the field was 13,145 pounds, or at the rate of 5,658 pounds per acre. The second cutting for 1906 was made August 2. The rainfall from June 12 to the time of second cutting was 6.53 inches. Before the second crop was fully cured

[a] Compiled from Oklahoma Sta. Rpt. 1907, p. 21.

[b] For previous article on this subject see U. S. Dept. Agr., Farmers' Bul. 281, p. 10.

it began raining again and 5.36 inches of water fell on the hay before it was hauled in and weighed August 15. This thorough leaching reduced the weight materially, but the final weight of dry hay was 7,275 pounds from the 2½ acres, or 2,910 pounds to the acre. The third cutting was made September 18, and the hay cured without being rained upon. The total yield of cured hay for the field was 7,840 pounds, or at the rate of 3,136 pounds per acre.

The total yield of hay per acre for the season was 11,704 pounds or 5.08 tons. Land of the very same nature adjoining this field does not produce over one-half ton of prairie hay of inferior quality. Bermuda hay contains twice as much digestible nutrients as the best of prairie hay, is much more palatable, free from stems and weeds, and in every way superior to hay made from wild grasses. It is time Oklahoma farmers were beginning to wake up to the possibilities of this remarkable grass, not only as a pasture grass but also as a hay crop.

PROTEIN CONTENT OF FORAGE CROPS.[a]

VARIATION IN PROTEIN CONTENT.

Forage crops differ not only in yield or the number of tons of fodder produced per acre, but also in feeding quality or the quantities of valuable nutrients they contain. A comparative study of a large number of our common forage crops from this view point is reported by Prof. H. Snyder of the Minnesota Experiment Station. This investigator calls attention to the fact that by the use of more concentrated nitrogenous forage the amounts of the higher-priced grains and mill products generally employed in feeding may be decreased and, in consequence, a material financial saving effected. One of the most important constituents of all feeding stuffs is protein, and the most indigestible, and therefore the least desirable, constituent is crude fiber. It follows, therefore, that an increase in the protein and a decrease in the crude fiber content of forage crops is of great importance and value.

The observation was made in these investigations that forage crops when grown on well cultivated, fertile lands often contained from 25 to 30 per cent more protein and a smaller amount of crude fiber than when grown on poor soils. It is pointed out that a ration is not necessarily valuable in proportion to the digestible protein it contains, but that the important problem is the determination of the right combination of protein and carbohydrates that is to be fed to stock. Ordinarily the protein of the ration is supplied largely by the grains and the carbohydrates by the coarse fodders. It is stated that average forage crops furnish less than half of the protein of a mixed ration, and it is believed that more attention should be given to the production of forage crops of maximum protein content in so far as this is under the control of the farmer mainly by means of the

[a] Compiled from Minnesota Sta. Bul. 101.

kind of crop grown, the fertility of the soil, and the composition and character of the seed.

ALFALFA.

A comparison of analyses given shows the particularly high protein content of alfalfa, this being higher than that of clover and about twice as much as is found in timothy and prairie hay. Furthermore, alfalfa contains as much digestible protein as the average farm grains and mill products. Alfalfa also has the advantage of being cut at an earlier stage of growth than clover, which not only furnishes forage earlier in the season, but also tends to produce a fodder of a higher protein content.

CLOVER.

Clover is also one of the highest ranking protein producers among forage crops, and has the advantage that its culture is more familiar to farmers generally and that in many localities it is more easily grown than alfalfa. The number of cuttings, however, are in favor of the alfalfa crop when this is well established. Two crops of clover are usually produced each year, and the second is often considered the better for feeding purposes. Analyses given show that in the samples studied the second cutting contained a little more protein and less crude fiber than the first, and in samples from another crop the first cutting was found to contain 12.6 per cent, while those from the second contained 16.43 per cent of protein. It was observed that the maximum protein and usually the minimum fiber are produced on soils fairly well supplied with lime, available potash, and phosphoric acid, and that soils with the highest nitrogen content did not necessarily produce clover richest in protein. White clover is rich in protein and is in general a valuable plant, but when eaten in large amounts by horses it is said to often cause an abnormal flow of saliva, and is for this reason disliked by many horse owners.

An examination of many samples of alfalfa and clover seed of known purity and uniform ripeness showed that some seeds were dark brown in color and others lighter and of a yellowish tinge. Analyses of these dark brown and yellowish seeds showed in some instances a quite pronounced difference in protein content, amounting to more than 5 per cent in favor of the dark brown seeds, while in some samples the difference was less than 1 per cent. The dark brown seeds uniformly contained more protein than the light yellow seeds, and it is believed that as in wheat and corn glutenous and starchy kernels have a decided tendency to produce grains of the same type, so in the case of alfalfa and clover high protein seeds will produce crops of maximum protein content, and that therefore seed selection

for the purpose of increasing the protein content may be practiced with these crops as well as with the cereals. The results obtained showed that the physical characteristics of the seed indicate in a measure their chemical composition and offer a means of selecting alfalfa and clover seeds of high or of low protein content. These investigations suggest that for seeding preference should be given to the darker colored seeds of high germinating power.

PEAS.

Pea hay constitutes a valuable forage rich in protein, but its comparatively difficult cutting and curing is probably the cause of its limited use. While peas show as much diversity in color, density, and general physical properties as any seeds, a close examination will show two general types—yellowish and green seeds. Both types consist of individual seeds either darker or lighter in color. In eight hand-picked samples, each representing a different variety selected on this color basis, the protein content was found to range from 19.15 to 31.74 per cent. The darker colored and harder seeds contained 3.74 per cent more protein than the light colored seeds, which were richer in starch. This difference in the type of seed, as in the case of alfalfa and clover, is considered a factor valuable in the production of more protein in the pea crop.

SOY BEANS.

Samples of soy beans selected in the same way as the samples of peas showed a difference in protein content of 6.27 per cent in favor of the high protein type. A mixture of corn fodder and soy beans containing a larger proportion of soy beans than of corn fodder showed a protein content of 14.87 per cent, or about as much as is found in clover hay. The soy beans alone contained 19.82 per cent and the corn alone 9.54 per cent of protein.

RAPE.

The rape plant was also studied in this connection, and it was found that plants grown on manured land contained 4.61 per cent more protein than those grown on unmanured land. The statement is made that under average conditions the dry matter of rape contains as much protein as clover. While the separation of rape seeds into high and low protein groups is difficult on account of the lighter colored immature seeds, it was found, however, that when special care was exercised in the removal of immature seeds it was possible to select glutenous and starchy ones with a difference of over 1 per cent of protein in favor of the glutenous type.

CORN FODDER.

No forage is more easily grown or affords a larger amount of nutrients per acre than corn fodder. In dry matter content it ranges between wide limits, containing sometimes as high as 90 per cent of water when very green and only 15 per cent when mature and field cured. The dry matter of corn fodder when produced under the most favorable conditions on well tilled and fertilized land contains from 8 to 9 per cent of crude protein. In the sample studied a difference of 3 to 4 per cent in protein content is found in favor of corn fodder grown on well tilled and manured land over that grown upon similar but unmanured land. Attention is called to the fact that corn silage is quite variable in composition, depending largely upon the character of the corn at the time it is put into the silo. The average silage contains about 75 per cent water and 25 per cent dry matter. The dry matter usually contains from 6 to 10 per cent of crude protein and about the same per cent of other nutrients as fresh corn fodder. A chemical analysis of a sample of corn smut showed that this substance is richer in proteid and nitrogenous matter than the corn itself. Corn stover or the stalks and leaves after the grain is removed contained 7.10 per cent of crude protein in samples of good quality and 5.02 per cent in samples of poor quality.

BROME GRASS.

Bromus inermis has about the same general composition in feeding value as timothy hay, but as the fiber and nonnitrogenous compounds increase rapidly in the later stages of growth it requires early cutting in order to secure the highest feeding value. The dry matter of fresh pasture grass is characterized by a high percentage of protein, but the amount of water in this grass is also very high, ranging from 85 to 90 per cent. In many localities the use of grass-seed mixtures consisting of clover, timothy, redtop, and other grasses has been found more satisfactory and profitable than seeding with just one grass alone. This mixed herbage has a high feeding value, particularly when 25 per cent of the grass-seed mixture is clover. A mixed hay crop containing clover and growing on a well-manured and well-tilled soil will contain from 10 to 12 per cent of crude protein, and this is forage of a high protein class. In addition to being of a high protein value, such a forage is a good mechanical mixture and affords a variety in the ration.

OTHER FORAGE PLANTS.

The forage crops of high protein content, as clover, alfalfa, peas, vetch, soy beans, and rape, in field-cured or air-dried condition usually contain from 12 to 20 per cent of crude protein; while those of medium protein content, as corn

fodder, timothy, millet, blue-grass hay, prairie hay, and *Bromus inermis*, contain from 5 to 11 per cent. Because of this wide range it is evident why so much stress is laid upon the importance of forage of high protein content and why there is a saving of grain and mill products when such forage is used in the feeding of live stock.

The forage obtained from millet, rye, timothy, prairie grasses, corn, *Bromus inermis*, and pasture and meadow mixtures are classified as forage of medium and low protein content. Analyses presented show that the dry matter of millet when the crop has been properly grown has as much protein as timothy hay or corn fodder, but that when produced under poor conditions its protein value is low. It is shown that rye fodder contains about the same amount of crude protein as the best grades of timothy at the same stage of growth. Analyses of samples of timothy hay presented show a range in protein from 5.11 to 9.10 per cent. It was further noted that in the use of timothy hay from soil highly fertilized with barnyard manure 25 per cent more protein and less fiber were obtained than from that grown upon poor soil. If grown under the best conditions, timothy hay may contain as high as 9 per cent of crude protein and then may be classed as forage of a medium high protein content, but if grown under poor conditions and on poor soil it may contain less than 5 per cent of crude protein or not more than is found in the best grades of straw. Bright, mediumly fine high-grade prairie hay is shown to contain nearly 9 per cent of protein and coarse low-grade, overripe and bleached samples less than 5 per cent.

WEEDS.

Analyses of 18 samples of the more common weeds showed that many of them withdraw large amounts of nitrogen from the soil. The large amount of protein in the dry matter was particularly noticeable in purslane, lamb's-quarters or pigweed, and cheese weed or mallow. It is stated that there is more protein in the dry matter of these weeds than in either alfalfa or clover, and it is suggested that it is advisable to keep a few sheep on every farm for utilizing and controlling the weed crop in order that under such a system the land may be reclaimed and the weeds utilized for both forage and green manure.

The foregoing facts suggest that by judicious selection and simple methods of improving forage crops with reference to protein content the feed bills now made up so largely of expenditures for costly concentrated feeds to supply the deficiencies of farm feeds in protein may be greatly reduced.

QUALITY IN WHEAT.[a]

Wheat growers are especially desirous of varieties which are resistant to disease and which give a large yield; millers are particularly interested in the yield and quality of flour, and bakers in the appearance and character of the goods which the flour produces.

In discussing the quality of wheat, one has to consider both the miller's and the baker's point of view. These two are often confused, and the term "milling quality" or "milling value" is sometimes employed in the same sense as "baking quality." The miller desires primarily a large yield of flour of good appearance, while the baker is not directly interested in the yield, but requires the flour to be of such appearance and strength as will suit his particular purposes. It might happen, therefore, that a sample of wheat of excellent milling quality might yield flour quite unsatisfactory to the consumer, and, on the other hand, a poor, somewhat shriveled sample of wheat might give a small yield of flour possessing admirable baking qualities.

In referring to flour, the terms "quality" and "strength" are often used as if they had the same significance, which is not strictly true. The term "strength" conveys a fairly definite idea, even though slightly different meanings may be attached to it at various times. "Quality," however, obviously signifies suitability for the purpose intended. A flour of high quality for pastry is a flour of low strength, whereas a flour of high quality for the production of very light bread or for mixing to improve the strength of weak flours must be of high strength.

Many tests designed to show quality have been devised, some of them simple and others very elaborate. In milling tests the weight of wheat per measured bushel and the percentage yield of flour of better grades are the important considerations. In baking tests the amount of water taken up by a given quantity of flour, the amount retained in the bread, the volume of the loaf, the form of crust, the texture and inside color of the loaf, the time of fermentation, and other similar factors are usually determined. With the data secured by such tests it is possible to so grade the flours that commercial requirements are met, for the majority of persons in purchasing bread disregard flavor, nutritive value, and digestibility and consider appearance only.

A number of the agricultural experiment stations in the United States have studied composition, particularly protein content, as related to yield, and milling quality of different varieties of wheat. Of late work may be mentioned the Virginia Experiment Station tests, reported by P. O. Vanatter, in which it was found that of a number of winter wheats Iron Clad had the highest protein content, namely, 17.20 per cent, while the lowest, 14.6 per cent, was found in Blue Ridge. Blue Straw Fultz, Fulcaster, and Mediterranean also

[a] Compiled from Colorado Sta. Rpt. 1905, p. 24; Minnesota Sta. Bul. 102; Nebaska Sta. Bul. 89; Virginia Sta. Rpt. 1906, p. 50; Canada Cent. Expt. Farm Bul. 57.

had high protein content, the values found being 16.80, 16.73, and 16.72 per cent, respectively. Turkey Red did not give good results at the Virginia Station.

At the Colorado Station, W. H. Olin in reporting the results of a study of the comparative value of different varieties of wheat states that Defiance was found to be the best spring wheat and Turkey Red the best winter wheat for milling purposes. In this and many other reports of experiment station work the relative yield of different varieties and the weight per bushel are factors which are also taken into account.

C. E. Saunders, of the Central Experimental Farm, Ottawa, Canada, has reported an extended study of the baking quality of a large number of varieties of wheat, this work being of great importance in connection with the studies which are being carried on at the Dominion experimental farms with a view to breeding new varieties of high quality. The samples were ground in an experimental mill and classified according to their milling qualities. The flour was stored under uniform conditions and the baking tests were elaborate and carefully made.

Of the numerous varieties tested Red Fife stood first in the two years' work as regards baking strength, volume, and shape of loaf, Laurel ranking lowest the first year and Grant and Ebert the second year. The following varieties yielded flour of high strength in the second-year tests, which were more extended than those carried on the first year: Bobs, Chelsea, Marquis, Early Russian, Gatineau, Haynes Blue Stem, Outlook, Hungarian White, Red Fern, and White Fife C. Professor Saunders states that Colorado, Herisson Bearded, and White Russian were of rather low strength and therefore not suitable for the production of extremely light bread or for export to countries desiring strong flour.

Of the winter wheats, included in the second year's work, Dawson Golden Chaff was rather low in strength, but produced good bread of pale appearance and rather compact character. Padi wheat the author considers unworthy of general cultivation, particularly on account of the greenish-yellow color of the inside of the loaf. Reference is also made in the report to the characteristics of other varieties tested.

As regards the effect of storage on quality, it was found that flour stored a year improved in every respect, " taking up a large amount of water, retaining more, giving a loaf of larger volume and of better shape, crust, texture, and color. The behavior of the dough in the oven was most remarkable. While in the first tests, with a water absorption of 59 per cent, the dough had a tendency to fall after the twelve-months keeping, although the water was increased to 62 per

cent, the dough had the ability to rise to a most remarkable degree when put into the oven. The sample of flour was kept for the twelve months under dry conditions in a glass-stoppered bottle. It would appear that this astonishing change in baking strength must have been due to an improvement in the quality of the gluten, as it could scarcely be explained on any other supposition."

The author does not consider appearance a trustworthy indication of quality. "There is no doubt some justification for the preference of bright samples of grain, that is, those which are free from blemishes, usually caused by frost or rain; but it is quite uncertain in many cases to what extent the actual quality of the interior of the kernal has been lowered when there is evidence of injury to the bran. It is often highly probable that the interior of the berry is in essentially perfect condition even though the bran may be dull and unattractive."

In this connection it is interesting to note that T. L. Lyons and A. Keyser report that "yellow berries," which are chiefly due to allowing wheat to become overripe and failure to stack the sheaves, had a lower gluten content, though lighter in weight, than the red normal kernels of the hard winter wheat studied at the Nebraska Station.

Contrary to the opinion of some other investigators, Professor Saunders found that two flours mixed in equal proportions gave results in baking tests which were a very close average for the varieties used.

In the principal tests which were carried on at the Central Experimental Farm the bread was uniformly made with a large proportion of yeast. To determine whether this factor influenced quality, additional tests were made under other conditions, but none of the variations introduced materially changed the rank of the different flours as already determined.

Professor Saunders also studied the quality of flour when baking powder was used instead of yeast.

All the flours tested produced biscuits of about the same volume, and though they differed somewhat in character and considerably in color the differences were not so striking as those observed in bread. It appears that almost any flour will make tea biscuits of fair quality. The experiments show that the flours tested had sufficient strength of gluten to attain the necessary volume when the gluten had not been subjected to the prolonged influence of the yeast fermentation and when the quantity of gas evolved was not very large, for it must be borne in mind that even a well-made tea biscuit has a small volume compared with that of a very light loaf of bread produced from the same quantity of flour. In spite of the similarity in conduct of the various flours under the conditions just mentioned, it is clear that one is not justified in concluding either that the gluten of all flours is practically identical or that the volume of a light loaf of bread is determined primarily by the quantity

of gas evolved. The making of ordinary tea biscuits can not be considered a test of the ability of gluten to withstand fermentation or of its power to retain a large quantity of gas produced inside the dough.

Two durum or, as they are often but less satisfactorily called, macaroni wheats were included among the varieties tested by Professor Saunders. The results which he obtained conclusively show, in his opinion, that the custom of regarding all such wheats as of one quality is absurd.

While the ordinary Goose (or Wild Goose) can not be recommended for bread making, the Kubanka produced admirable bread, which, however, differs in some ways from that produced from most of the other wheats. The Kubanka dough must be made rather stiff in order that it may not be too sticky to handle conveniently. It rises very well, producing a large loaf of very fine texture and of good form. The crust is somewhat unusual, being of a rich brown color and having a tendency to be thin and tough. The inside color of the bread is quite yellow, but this gives an appearance of richness and can only be objected to on the grounds of prejudice. Taking all its characteristics into consideration, * * * the bread produced from this sample of wheat was of excellent quality.

These conclusions are in accord with similar work reported from a number of the experiment stations in the United States.[a]

In a recent bulletin of the Minnesota Station, Prof. H. Snyder reports experiments which show quite conclusively that not only the variety, but also the method of fertilizing, may be an important factor in determining the quality for bread-making purposes of the wheat produced. He made chemical analyses and milling and baking tests of 41 samples of flour milled from wheat grown upon fertilized and unfertilized plats at nine different places. In 30 of the 41 tests the fertilizer which gave the largest yields per acre produced wheats of the highest bread-making quality. It appears, however, that while both yield and bread-making quality are improved by the use of fertilizers they are not necessarily improved to the same extent by the same fertilizer.

There appears to be no constant relationship between the percentage of protein in the grain and flour and the bread-making value, and while it is possible to increase the amount of proteids in flour by the use of nitrogenous fertilizers the bread-making value of the flour is not proportionately increased. In many instances the increase in nitrogen content imparts a negative value, as a part of the nitrogen is in nonproteid forms.

The experiments taken as a whole show that not only the yield of wheat, but also the bread-making value, can be enhanced by increasing the fertility of the soil, and that there is a very close relationship between the amount of available plant food in the soil and the quality of the wheat produced upon the soil and its bread-making value.

[a] U. S. Dept. Agr., Farmers' Buls. 186, p. 6; 251, p. 14. See also U. S. Dept. Agr. Yearbook 1903, p. 329.

The importance of composition and digestibility of wheat flours and other cereal products, the value of such foods in the diet, and various questions concerned with bread and bread making have been considered in earlier Farmers' Bulletins of the Department.[a]

DOES IT PAY TO SPRAY POTATOES?[b]

As stated in a previous bulletin of this series[c] the New York State Experiment Station has in progress in cooperation with growers in different parts of the State a ten-year test of the profitableness of spraying potatoes as a protection against diseases and insect pests. During each of the five years that these tests have now been carried on, spraying with Bordeaux mixture and arsenicals has proved a useful and profitable practice. During the last of the five years reported upon to date, namely, 1906, the season "was in most parts of the State the least favorable of any of the five for the development of the principal potato disease, late blight and rot; yet in nearly all of the 80 tests reported spraying gave good returns for the money expended and labor applied."

The average net profit from spraying in 15 cooperative experiments carried out during the season of 1906 was $13.89 per acre, the net profit from similar experiments in 1905 being $20.04, in 1904 $24.86, and in 1903 $23.47.

"The highly favorable results obtained in the numerous experiments made by the station and by New York farmers during the past five years should stimulate potato growers to give spraying a trial. If it really is as profitable as these experiments indicate, they can not afford to neglect spraying."

The following recommendations regarding methods of spraying are made:

In general, commence spraying when the plants are 6 to 8 inches high and repeat the treatment at intervals of ten to fourteen days in order to keep the plants well covered with Bordeaux throughout the season. During epidemics of blight it may be necessary to spray as often as once a week. Usually six applications will be required. The Bordeaux should contain 4 pounds of copper sulphate to each 50 gallons in the first two sprayings and 6 pounds to 50 gallons in subsequent sprayings. Whenever bugs or flea-beetles are plentiful add 1 to 2 pounds of Paris green or 2 quarts of arsenite of soda stock solution to the quantity of Bordeaux required to spray an acre.

Thoroughness of application is to be desired at all times, but is especially important when flea-beetles are numerous or the weather favorable to blight. Using the same quantity of Bordeaux, frequent light applications are likely to be more effective than heavier applications made at long intervals; e. g., when

[a] U. S. Dept. Agr., Farmers' Buls. 112, 114, 192, 249. See also U. S. Dept. Agr. Yearbook 1903, p. 347.

[b] Compiled from New York State Sta. Bul. 290.

[c] U. S. Dept. Agr., Farmers' Bul. 251, p. 9.

a horse sprayer carrying but one nozzle per row is used, it is better to go over the plants once a week than to make a double spraying once in two weeks. A good plan is to use one nozzle per row in the early sprayings and two nozzles per row in the later ones.

Those who wish to get along with three sprayings should postpone the first one until there is danger of injury from bugs or flea-beetles and then spray thoroughly with Bordeaux and poison. The other two sprayings should likewise be thorough and applied at such times as to keep the foliage protected as much as possible during the remainder of the season. Very satisfactory results may be obtained from three thorough sprayings.

A single spraying is better than none and will usually be profitable, but more are better. Spraying may prove highly profitable even though the blight is only partially prevented. It is unsafe to postpone spraying until blight appears. Except, perhaps, on small areas, it does not pay to apply poison alone for bugs. When it is necessary to fight insects use Bordeaux mixture and poison together.

The previous note on this subject referred to at the beginning of this article suggests that in order to secure economical and efficient spraying the growers might arrange for a "public sprayer," that is, some one man in a neighborhood who would make a business of spraying and would secure enough fields to keep him busy throughout the season.

USE OF ANESTHETICS IN FORCING PLANTS.[a]

Attention was called in a previous bulletin of this series[b] to the importance of controlling the dormant period of peaches, with special reference to preventing premature formation of buds and their subsequent destruction by frosts or freezing. Such control is now generally recognized as practicable with many plants and of value in their commercial production. Various means are employed to control the dormant period of plants, such as pruning, covering, attention to condition of growing wood in case of woody plants at the beginning of the period, and the like. In recent years attention has been turned to the use of anesthetics such as ether, chloroform, etc., for this purpose, especially with certain flowering and herbaceous plants. This method of treatment has been successfully practiced to some extent in Europe, but has not assumed commercial importance in this country.

Experiments by the Vermont Experiment Station with the use of ether in the forcing of rhubarb has been noted in a former bulletin of this series.[c] In a report of later experiments by this station along the same line, W. Stuart says:

The use of anesthetics as an aid in the forcing of flowering shrubs, tuberous and bulbous plants, and herbaceous perennials, has not as yet assumed com-

[a] Compiled from Vermont Sta. Bul. 129; Rpt. 1906, p. 279.

[b] U. S. Dept. Agr., Farmers' Bul. 316, p. 6.

[c] U. S. Dept. Agr., Farmers' Bul. 233, p. 18.

mercial importance among growers in this country. In Germany and France, however, they are now used extensively in many of the large commercial establishments. Their use at the present time is almost wholly confined to flowering shrubs, such as lilacs, viburnums, deutzias, spireas, azaleas, etc., which lend themselves most readily to anesthetic influences. This class of plants come into bloom early in the spring, complete their growth at a comparatively early date, and then pass into a state of rest. Normally plants will not start into growth until they have entered into the latter part of the rest period. The largest measure of success, therefore, in the use of anesthetics must necessarily come from plants subjected to the influence of ether or chloroform during the earlier stages of rest.

The process of treatment is a comparatively simple one. Plants which are either dormant or are entering into the stage of dormancy are subjected to the vapor of ether or choloroform in an air-tight room or receptacle for from twenty-four to seventy-two hours, depending upon the earliness or lateness of the treatment and the temperature, the anesthetic being poured from above into an open vessel within the receptacle. The amount used per cubic foot of air space is largely governed by the temperature, moisture, season of year, and kind of plant to be treated. The higher the temperature and the later the season the more violent is the effect; hence the amount and time of exposure may be said to vary inversely with the temperature and the season when treatment is given. Apparently there is greater latitude in the amount that plants will stand than is currently believed. The action of chloroform is much more intense than that of ether, and only one-third to one-fourth the amount should be used.

The relative increase in earliness of blooming period of treated over untreated plants varies inversely to the earliness or lateness of the forcing period. It is claimed that growth is hastened about a month by treatment. The amount of bloom is considerably increased thereby, but on the average a gain of from ten to fifteen days is about all that may be expected.

As a result of his own experiments and of those of other investigators, Professor Stuart believes that "the anesthetization of flowering shrubs, such as lilacs, virburnums, azaleas, deutzias, spireas, etc., is a feasible and practical commercial enterprise for the florist." He found in his later experiments, as in the earlier, that etherization of rhubarb plants for winter forcing resulted in an increased yield, but that freezing of the rhubarb clumps at least early in the season, as is generally done in rhubarb forcing, is a necessary preliminary process, since etherization does not seem to perform the same function as freezing. He is of the opinion, however, that actual freezing may not be necessary for late forcing.

The action of ether on asparagus, potato tubers, apple, and palm seeds was also studied in the Vermont Station experiments.

There seems to be some evidence of a responsive action on the part of asparagus to ether, but the results secured thus far are so inconclusive as to preclude definite statement.

Dormant potato tubers were treated similarly as was the rhubarb, but in no case was there evidence of either beneficial or deleterious effect upon vegetation.

The etherization of apple seeds did not visibly accelerate germination; nor from the data now at hand is there likelihood that any beneficial results will accrue from the etherization of palm seeds.

The use of anesthetics would seem to have some promise of practical value in the forcing of plants, especially as an aid in more completely controlling the period of maturing of the desired product, but undoubtedly many of the details of the practical applications of the method and the limits of its usefulness remain to be worked out.

FATTENING CATTLE FOR MARKET.[a]

In connection with extensive studies of problems concerned with fattening cattle for market, the Missouri Experiment Station has collected information from nearly 1,000 of the most successful cattle feeders in Missouri, Iowa, and Illinois, which represents experiences extending over periods of nearly twenty years and with an aggregate of approximately 2,000,000 cattle. The station has recently published a digest of these data and the results of the numerous experiments on a wide range of topics concerned with fattening cattle which have been carried on by the station.

In the opinion of Director H. J. Waters, who has compiled and summarized this information, methods which are based on the experience of successful men are in general satisfactory.

> The practical man in the long run arrives at correct conclusions on the main points involved in his practice. A theory that runs counter to the conclusions of men of long experience or to the principles of a long established practice should be well considered and should have the support of extensive and accurate experimental data before being accepted.

The duration of the feeding period is a matter of great importance in successful cattle feeding. As shown by the data collected from practical feeders, the average length of the full feeding period was one hundred and seventy-seven days, or practically six months. Little variation from this average was noted, and this factor seems to be fairly well established.

In Missouri the weight of the steer returning the greatest profit was 1,345 pounds, in Iowa 1,358 pounds, in Illinois 1,390 pounds, and in Nebraska 1,400 pounds, or on an average 1,367 pounds. In general 1,500 to 1,600 pound steers have not been profitable.

Cattle were put on full feed at 2 years of age by 40 per cent of the feeders and by 24 per cent at 2½ years of age.

> Evidently the corn-belt cattle feeder is not yet making baby beef. This is due to the fact that older cattle feed more uniformly, finish in a shorter time, and with less attention to the details of feeding. Of even more importance perhaps is the fact that older cattle may be bought as feeders with enough more margin than young cattle to make the feeding operation, on the whole, more profitable. It is furthermore shown that aged cattle are in somewhat better demand on the market, especially if somewhat underdone or of plain quality.

---

[a] Compiled from Missouri Sta. Bul. 76.

In the matter of the most favorable season for fattening cattle, the practical feeders consulted showed a decided preference for summer, or at least for some season other than winter. The experiments which Director Waters has summarized show that cattle gained much faster in summer than in winter and at about four-fifths the cost of winter feeding. It was also apparent that pigs following summer-fed cattle made better gains and that less labor is required for feeding, hauling manure, etc.

Gains are cheaply made on grass alone, but are low-priced, because the cattle are not in marketable condition and must be sold as feeders with sufficient margin to enable the buyer to fit them for market.

The season of the year affects the market demand of cattle. Certain weights and classes are required for certain seasons, while other weights and classes will meet the best demand at other seasons. The steer that is staple the year round is the thick-fleshed native, weighing from 1,200 to 1,400 pounds. This class answers the demand of the dressed beef, the live export, the dead export, and the eastern shipper trade. Or, all classes of buyers use a greater or less number of these cattle throughout the year, making them staple at steady prices.

Yearlings weighing 900 to 1,100 pounds when well finished and not offered in too large numbers find a steady market and a good demand throughout the year. When plain in quality, or somewhat underdone, or when a little oversupplied, the price declines sharply, because this class has a more limited use than the dressed beef steer just described.

Three-year-old cattle weighing 1,500 to 1,600 pounds find a good demand for hotel and resort trade the year round if not offered in too large numbers. The demand is better one year with another from the latter part of the summer to the 1st of December than at any other time for this class of cattle. They do not need to carry so much quality or finish as yearlings or even dressed beef steers to sell at the highest price for their class.

A great variety of opinions were expressed as to the value of roughage in full feeding, though in general the data collected show that feeders were indifferent as to the kind or quality of this part of the ration. Experiments conducted at the Missouri Station show that coarse fodder decidedly affects the rate and cost of gain and the finish of the cattle. It has been found that with cattle bringing 5 cents a pound corn combined with clover hay and cowpea hay was worth 8.25 cents more per bushel than when combined with timothy.

A large roughness consumption does not necessarily mean a diminished grain consumption. If the roughness be a legume hay, such as clover, or cowpeas, or alfalfa, the amount consumed will be materially larger than when it is timothy, or corn stover, or prairie hay, or millet, and at the same time the cattle will eat a larger amount of grain. The extra amount of protein in the legume hay has the effect of stimulating a larger total consumption of feed, a considerable portion of which is grain.

As regards the value of shelter in full feeding, it is shown, as a result of four years' experimental work, that steers on full feed gain more rapidly and somewhat more economically when having access to an open shed, or even when confined in an open lot, than when sheltered in a well ventilated barn.

There is a direct relation between the quality and condition of the feed and the ease and readiness with which cattle may be accustomed to it. Cattle may be

gotten on full feed more quickly when coarse and relatively unpalatable material is used than when highly nutritious and well prepared feeds are used. * * *

The amount of margin required to cover the expense of fattening and pay a profit is governed by a variety of circumstances. Younger cattle require a smaller margin than older cattle, because they make cheaper gains. Short fed cattle a smaller margin than long fed cattle, because the costs of gains is higher the longer cattle are on feed. Cattle of high quality require a narrower margin than cattle of poor quality because of the higher price at which they sell when finished. A larger margin is required in winter than in summer, because, it requires more feed to make a pound of gain. The higher the price of feed, the larger the margin required, unless the price of finished cattle has correspondingly increased.

The farmers interviewed reported an average margin of $1.02 per hundred for a six months feed on 2-year-old cattle in the summer. It is estimated that for a similar feed in winter approximately $1.50 would be required.

It was apparent from the data collected that the average feeder gives comparatively little attention to the preparation of feed. About one-half of the feeders in Missouri, Illinois, and Iowa use ear corn exclusively, and if the feeders are included who use ear corn for part of the fattening period the proportion is much larger. Considering the data as a whole, shelled corn was fed dry either exclusively or at some season of the year by about 25 per cent of the feeders and corn-and-cob meal and ground shelled corn by less than 10 per cent on an average. A large number of the feeders made more effort to supply well prepared feed at the end of the fattening period than at the beginning or middle, with the object of maintaining satisfactory gains, as the feeding progressed, by catering to the appetite.

At this time the system is loaded with fat and the maintenance cost per steer is very high; at the same time the appetite is variable and is disposed to decline. Anything, therefore, that tends to increase the amount of food consumed will affect favorably the rate and cost of gain.

Better preparation is required in summer than in winter feeding, because the grass in summer is more palatable than the roughage used in winter, and for a large enough consumption of grain to produce a profitable gain it is required that the grain be palatable. Moreover, grain in summer is dry, hard, and more difficult to masticate, and is liable to have been somewhat fouled by mice and rats. These difficulties are in practice usually overcome by soaking the corn from twelve to eighteen hours.

Better preparation of grain is required for young cattle than for aged animals, in order to stimulate the most rapid possible gain. This is necessary to finish the younger animals within a reasonable time. They use so large a proportion of their food for growth that a high rate of gain is necessary to make them fat quickly.

The real reason for preparing grain for cattle is not to reduce the proportion of grain passing through the animal undigested, but rather to increase the rate of gain. This is so because whatever part of the grain the steer fails to utilize the hogs which follow the cattle will utilize to good advantage.

The feeder is interested primarily in the aggregate gain of steer and hog per unit of grain fed, and can not afford, under the ordinary farm conditions,

to invest much labor and money in the preparation of feed which increases the steer gains wholly or mainly at the expense of the hog gains. So long as the food is offered in palatable enough form to make the steer gain at a rapid rate and make him fat in a reasonable time, the feeder is not interested in how much passes through the steer unmasticated or undigested, because the hog will make good use of it.

Taking the average price of all fat hogs and all the fat steers sold on the Chicago market for the past twenty-four years, it has been found that the hogs have brought a higher price per pound. It will be accepted without argument that less food is required to make a pound of gain on hogs than on cattle. As a rule, therefore, the hog end of the cattle feeding operation is more profitable than the cattle end.

The number of hogs required to utilize the waste per steer will vary greatly with the character of the feed, the way in which it is prepared, and with the size and age of the cattle. The range would be * * * at the rate of two to three hogs per steer on snapped ear corn, perhaps one and one-half on husked ear corn, about one on shelled corn, and from one-third to one-half a hog on crushed or ground corn.

Whatever factors favor rapid and profitable gains on cattle, excepting the better preparation of the feed, are liable to be favorable to the hog that follows. For example, hogs make better gains following cattle fed on clover or cowpea or alfalfa roughness with corn than they do when the roughness is timothy, millet, or sorghum. Likewise there is a material benefit to the hog by feeding the steer a limited amount of linseed meal. There is also a benefit to the hog from feeding cotton-seed meal to the steer, although it is less marked than when linseed meal is used.

It is almost as profitable to use a supplemental feed like tankage or linseed meal for hogs that are following cattle as for those that are being fed on fresh grain. Especially is this true of hogs following cattle fed on straight corn with timothy or stover for roughness in winter or blue grass or timothy pasture in summer. Likewise a clover, alfalfa, cowpea, or soja-bean pasture for hogs following cattle will affect just as favorably the profits as though the hogs were not following cattle. In view of the fact that a considerable part of the profit of steer feeding is in the hog gains, it is important that most careful attention be given to the hogs, in order that the maximum gain may be secured.

An abundant supply of pure water convenient to the feeding bunks and to the grazing grounds is absolutely imperative. It is fatal to good results to require the cattle to travel long distances to water or to drink from pools or troughs that are befouled by hogs or other stock. A steer on full feed and under the strain of rapid production requires a large quantity of water daily.

Cattle that are being fattened should be fed with the utmost regularity, should be kept as quiet as possible, and should be encouraged to lie down when not eating. They should never be frightened or disturbed in any way.

Changes in feed, location, or surroundings of cattle that are fat should never be made, except such as are decidedly for the better, and even then should be made only when most imperative.

COTTON-SEED MEAL AND CORN SILAGE FOR DAIRY COWS.[a]

John Michels and J. M. Burgess, of the South Carolina Station, state that " there is a prevailing belief that when cotton-seed meal is

[a] Compiled from South Carolina Sta. Bul. 131.

fed for long periods in quantities exceeding 4 pounds per cow daily the health of the animals will be more or less injuriously affected," but in a series of experiments which they report it was found that cotton-seed meal may be fed in conjunction with good corn silage to the extent of from 5 to 6 pounds per cow daily without affecting the health of the animals. Indeed such a ration appeared to keep the cows in an unusually good state of health. A ration consisting of cotton-seed meal and good corn silage was consumed by the cows with great relish, which was in no way lessened when the feeding of such a ration was continued for a period of five months.

No bad effects were noticeable from the practice of feeding cotton-seed meal and corn silage separately. On the contrary, such a practice appears to have distinct advantages over the common practice of mixing the meal with the roughage. Our results, therefore, tend to disprove the prevailing belief that heavy concentrates like cotton-seed meal will act detrimentally on the health of cows when fed unmixed with more bulky feeds.

Cows fed exclusively on cotton-seed meal and corn silage for a period of five months exhibited no craving for dry roughage, but always preferred silage to good hay.

According to the herd records, the cows yielded more milk and butter fat during this experiment than during any corresponding period in previous years. Cotton-seed meal and rich, well matured corn silage constitute an excellent ration for cows yielding from 20 to 30 pounds of milk daily.

These results are of special importance because cotton-seed meal and corn silage form by far the cheapest dairy feeds available to dairymen in South Carolina and elsewhere in the South. It is stated that the cost of such a ration is only slightly more than half that of the common dairy ration now fed in the State.

The good results obtained in these experiments in the exclusive feeding of cotton-seed meal and corn silage as a dairy ration was attributed largely to the fact that the corn silage was made from well matured corn rich in grain, making it especially rich in carbohydrates, for it is explained that unless silage is especially rich in grain a ration consisting entirely of corn silage and cotton-seed meal will be deficient in nonnitrogenous matter (carbohydrates).

It is believed that " with cotton-seed meal furnishing an unusually cheap protein supply, and with the great yields of corn possible in this State * * * milk can be produced as cheaply, if not more cheaply, in South Carolina than in any other portion of the world."

CARBONATED MILK.[a]

L. L. Van Slyke and A. W. Bosworth, of the New York State Station, report that in making a study of the chemical changes which

[a] Compiled from New York State Sta. Bul. 292.

occur in koumiss made from cows' milk it was noticed that lactic acid formed much more slowly in the koumiss than in ordinary milk. This was found to be due to the action of carbon-dioxid gas under pressure.

A series of experiments was therefore undertaken to ascertain the effect of carbon dioxid under different pressures upon the development of lactic acid in milk. These experiments were made with (1) fresh separator skim milk, (2) fresh whole milk drawn and handled under good hygienic conditions, (3) fresh skim milk pasteurized at 185° F., and (4) fresh whole milk pasteurized at 185° F.

The best results were secured when newly pasteurized milk or cleanly drawn fresh milk was treated with carbon dioxid in a tank, such as is used in bottling establishments in preparing carbonated drinks, and then placed in siphon bottles. When charged under pressures of from 70 to 75 pounds and kept at temperatures ranging from 35° to 60°, bottles of clean fresh milk or pasteurized milk kept from four to five months without perceptible increase in acidity.

Milk carbonated under a pressure of 70 pounds comes from the bottle as a foamy mass, more or less like koumiss that is two or three days old. It has a slightly acid, pleasant flavor, due to the carbon dioxid, and has a somewhat more salty taste than ordinary milk. In the case of carbonated milk pasteurized at 185° F., there is, of course, something of a "cooked" taste. Though the cream separates in the bottle, it is thoroughly remixed by a little shaking as the milk comes from the bottle, and there is no appearance of separate particles of cream. All who have had occasion to test the quality of carbonated milk as a beverage agree in regarding it is a pleasant drink. In the case of milk bottled under a pressure of 150 pounds of carbon dioxid, the milk delivered from the siphon is about the consistency of whipped cream, but, on standing a short time it changes into a readily drinkable condition.

Carbonated milk furnishes a pleasant beverage, and it is suggested that it may find practical use as a healthful drink and as a valuable food for invalids and children in cases where ordinary milk does not digest well.

It is pointed out that in order to prepare carbonated milk successfully "the milk should be drawn so as to be as free as possible from dirt, and promptly cooled below 45° F. It should be carbonated within a few hours. All the vessels with which the milk comes in contact, from milking to bottling, should be carefully sterilized before use. In case milk can not be carbonated quite promptly after drawing, it should be thoroughly pasteurized before being charged and bottled."

PRESERVATION OF FENCE POSTS.[a]

As H. F. Weiss in a recent circular of the Forest Service of this Department points out, it is each year becoming more difficult to secure satisfactory fence posts, and since substitutes such as reen-

[a] Compiled from Wyoming Sta. Bul. 75; Rpt. 1897, p. 29; U. S. Dept. Agr., Forest Service Circ. 117.

foreed eonerete and iron are probably too eostly to compete with wooden posts, the only solution of the diffieulty lies in the use of cheaper woods and in preventing decay by preservative treatment.

A great variety of preservative treatments have been tried with varying success. B. C. Buffum, of the Wyoming Experiment Station, reports that he has been able to preserve piteh-pine posts with but little injury for sixteen years by dipping the lower ends of the posts in crude petroleum to a suffieient distance to come above the ground line when the posts are set, and burning off the oil. He states that "this dipping can be done very eheaply and will undoubtedly pay. A seeond method is to simply dip 2½ feet of the bottom of the posts in erude petroleum or in tar; this did fairly well. The oil seemed a better protection to the posts than did the eoal tar. Posts that were well eharred by burning came in about third plaee. * * *

There is little advantage to be gained by simply oiling or tarring a band to protect the post from dry rot where it comes through the ground, and less from any treatment of only a portion below the ground. Such oil band helped preserve the post, but the time taken to apply the oil in this manner would make it more expensive than dipping the entire lower end of the post.

The Forest Service has made a very careful study of the subject of preservation of posts, and has obtained the most satisfactory results on the whole with the creosote treatment. The chief merit of this treatment is that it renders inferior woods as serviceable as those of better quality, thus saving the latter for other purposes and aiding in eonserving the rapidly diminishing supply of the more valuable woods.

The process of treatment with creosote has been greatly eheapened by what is known as the "open-tank" method introduced by the Forest Serviee. It is stated that the necessary equipment for this treatment ean be installed at a eost of from $30 to $45, or for much less if an old boiler is used. The essential requirements are that the creosote shall be heated to about 215° F. and that the butts of the posts shall be submerged up to about 6 inches above their ground line. A tank with a bottom 12 square feet in area has been found of sufficient size for treating forty to fifty 6-inch posts a day, or double that number when two runs per day can be made, as is possible with lodgepole pine posts. The amount of creosote absorbed was found in the Forest Serviee experiments to vary from one-tenth gallon with Eucalyptus posts to seven-tenths gallon with sycamore, cottonwood, and lodgepole pine. At the time these experiments were made the price of ereosote varied from 10 eents per gallon in the East and Middle West to 27 cents per gallon in the Roeky Mountain States, and was about 16 cents per gallon on the Pacifie coast. On the basis of these

figures it is estimated that the cost of treating a post varied from 4 to 15 cents.

In experiments with the preservative treatment in Idaho it was found that the durability of lodgepole pine posts was increased sixteen years. On this basis, and notwithstanding the high price of creosote in Idaho, it is estimated that by treating the posts there was a saving with interest at 6 per cent of 2 cents per post yearly. It is pointed out that since the resistance of all treated posts to decay is alike regardless of the kind of wood only the cheaper kinds of woods should be used for posts, and, further, that as sapwood is more readily impregnated with creosote than heartwood, posts containing much sapwood are to be preferred to those which are largely of heartwood. It is quite important that the posts should be air dry before they are treated or set. "They should be cut at least a month before treatment. Wood dries fastest in spring or summer, but with those species which check badly, such as the oaks, cutting is best done in autumn or early winter."

Both the inner and outer bark should be completely removed before treatment. Round posts are, as a rule, preferable to split posts.

If butt treatments in the open tank can not be given, and yet some preservative method is desired, plunge the butts of the posts into a vessel of hot creosote or carbolineum or apply either liquid with a brush. A long bath in hot creosote, followed by a shorter one in cold creosote, will probably give best results. Usually woods with a porous structure, like the poplars, can be treated more easily than dense woods, like the oaks, and hence need not be left in the creosote for so long a time.

The tops of posts should be cut slanting, preferably with an axe, so that the rain will not remain on them. If cut with a saw the pitch should be greater.

Setting posts small end downward has no effect in checking decay.

There is some advantage from piling stones around the base of the posts or setting them in masonry or concrete, but not enough to justify the cost.

Charring the butt of the post, if properly done, gives good results. The posts in this case should be thoroughly dry and the charring should extend at least 6 inches above the ground line.

Soaking posts in solutions of copper sulphate or mercuric chlorid is not considered a practical method of treatment.

Good results, particularly with soft woods like sycamore and cottonwood, have sometimes been obtained by boring holes diagonally into the posts just above the ground line and filling them with some preservative solution, such as various forms of coal tar, but it should be borne in mind that the posts are weakened by the boring of such holes.

O